

**U.S. DEPARTMENT OF COMMERCE
National Technical Information Service**

PB-266 398

**Immediate Water Pollution Control Needs
Canadian River Basin
New Mexico, Texas and Oklahoma**

Federal Water Pollution Control Administration, Dallas, Texas

Apr 67

IMMEDIATE WATER POLLUTION CONTROL NEEDS

CANADIAN RIVER BASIN

NEW MEXICO, TEXAS, AND OKLAHOMA

**UNITED STATES
DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTH CENTRAL REGION
DALLAS, TEXAS 75202**

APRIL 1967

**REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161**

TECHNICAL REPORT DATA <i>(Please read instructions on the reverse before completing)</i>		
1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE IMMEDIATE WATER POLLUTION CONTROL NEEDS CANADIAN RIVER BASIN NEW MEXICO, TEXAS AND OKLAHOMA		5. REPORT DATE April 1967
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS FEDERAL WATER POLLUTION CONTROL ADMINISTRATION Dallas, Texas		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Protection Agency 1201 Elm Street Dallas, Texas 75270		13. TYPE OF REPORT AND PERIOD COVERED
		14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES		
16. ABSTRACT The purpose of the report is to focus attention on known sources of water pollution in this area and to provide a priority for action to correct existing problems and to prevent future problems. <—		
17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Water Pollution Control Canadian River Basin New Mexico Texas Oklahoma		
18. DISTRIBUTION STATEMENT Release unlimited - Available from NTIS	19. SECURITY CLASS (This Report) 20. SECURITY CLASS (This page)	21. NO. OF PAGES 32 22. PRICE PC A03, MFA01

I. INTRODUCTION

The purpose of this report is to focus attention on known sources of pollution and to provide a priority for action to correct the existing water pollution problems and prevent future problems in the Canadian River, an interstate stream, and its tributaries. (See Figure 1) This report is based on compilations of available data of the Federal Water Pollution Control Administration, South Central Region, and the pollution control agencies of New Mexico, Texas, and Oklahoma. No detailed water quality surveys or engineering studies were carried out for the preparation of this report.

The findings of this report are based on the best information available at this time on water quality conditions and immediate and potential pollution abatement needs. The omission of any particular town, industry, or other establishment from this report does not imply that an immediate or potential pollution abatement need may not possibly exist at that particular location. Priorities listed are based solely on an evaluation of the Canadian River Basin and not on a relative basis with other basins in the South Central Region.

Authority is given in Section 3 (a) of the Federal Water Pollution Control Act, as amended, for the preparation or development of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary conditions of surface and underground waters. This report by describing the immediate needs for controlling water pollution in the Canadian River Basin represents another step in the development of a comprehensive program to control water pollution in this basin.

II. Summary of Immediate Water Pollution Control Needs

Widespread water quality problems indicated by rapid environmental changes in the river, high salt content, large silt loads, and low dissolved oxygen concentrations occurring in the Canadian River Basin are caused by salt and other minerals from natural and man-made sources, silt from erosion, bank caving, and channel storage, inadequately treated municipal and industrial wastes, cattle feedlot runoff, and water releases from reservoirs. Beneficial water uses which are prevented or damaged by these pollutants include municipal and industrial water supplies, fish and wildlife propagation, esthetics, and most forms of water related recreation.

The immediate pollution control needs are listed in the following tabulation and grouped into categories: waste treatment, flow regulation, other pollution control practices, institutional practices, and research. Location designations refer to Figure 1.

<u>Location</u>	<u>Responsibility</u>	<u>Need</u>	<u>Priority</u>
<u>Waste Treatment</u>			
1	Town of Maxwell, New Mexico	Provide new primary & secondary treatment plant	A
2	City of Tucumcari, New Mexico	Expand or modify secondary treatment plant	B
3	Town of Clayton, New Mexico	Expand or modify secondary treatment plant	B
4	Town of Texline, Texas	Improved operation	B
5	U. S. Dept. of the Interior, Bureau of Mines, Amarillo Helium Plant, Amarillo, Texas	Add secondary treatment unit to primary plant	B
	Panhandle Gravel, Inc., Amarillo, Texas	Provide sedimentation of suspended solids	A

<u>Location</u>	<u>Responsibility</u>	<u>Need</u>	<u>Priority</u>
<u>Waste Treatment (Continued)</u>			
5	City of Dalhart, Texas	Add secondary treatment unit to primary plant	B
	City of Gruver, Texas	Add secondary treatment unit to primary plant	B
	City of Spearman, Texas	Expand or modify present treatment facilities	B
	City of Stinnett, Texas	Expand or modify present treatment facilities	B
	City of Sunray, Texas	Add secondary treatment unit to primary plant	B
	Colo. Interstate Gas Co., Bivins Sta., Moore County, Texas	Provide treatment of domestic and industrial wastes	B
	Natural Gas Pipe- line Co. of America; Dumas Compressor Sta., Moore County, Texas	Provide additional treatment of domestic and industrial wastes	B
	Western Sand & Gravel, Inc., adjacent to Canadian River in Oldham County, Texas	Provide sedimentation of suspended solids	A
	City of Guymon, Oklahoma	Expand or modify secondary treatment plant (under construction)	B
6	City of Borger, Texas	Add secondary treatment unit to primary plant	B
	J. M. Huber Corp., Borger, Texas	Provide additional treat- ment of domestic and industrial wastes	B

<u>Location</u>	<u>Responsibility</u>	<u>Need</u>	<u>Priority</u>
-----------------	-----------------------	-------------	-----------------

Waste Treatment (Continued)

6	Phillips Chemical Co. Complex, West of Borger, Texas	Provide additional treatment of domestic and industrial wastes	A
7	Town of Skellytown, Texas	Add secondary treatment unit to primary plant	B
8	Town of Miami, Texas	Add secondary treatment unit to primary plant	B
9	City of Beaver City, Oklahoma	Add secondary treatment unit to primary plant	B
10	Town of Darrouzett, Texas	Add secondary treatment unit to primary plant	B
11	City of Laverne, Oklahoma	Add secondary treatment unit to primary plant	B
12	City of Follett, Texas	Add secondary treatment unit to primary plant	B
13	City of Higgins, Texas	Add secondary treatment unit to primary plant	B
14	Town of Shattuck, Oklahoma	Expand or modify secondary treatment plant	B
15	City of Woodward, Oklahoma	Expand or modify secondary treatment plant	B
16	Town of Chester, Oklahoma	Provide collection system and secondary treatment plant	B
17	Town of Canton, Oklahoma	Expand or modify secondary treatment plant	B
18	Town of Custer City, Oklahoma	Expand or modify secondary treatment plant	B

<u>Location</u>	<u>Responsibility</u>	<u>Need</u>	<u>Priority</u>
<u>Waste Treatment</u> (Continued)			
19	Town of Hydro, Oklahoma	Expand or modify secondary treatment plant	B
20	City of Bethany, Oklahoma	Expand existing secondary treatment plant (under construction)	B
	City of Del City, Oklahoma	Improve plant operation	B
	U. S. Bureau of Prisons, Federal Reformatory, El Reno, Oklahoma	Expand or modify secondary treatment plant	B
	Town of Geary, Oklahoma	Expand or modify secondary treatment plant	B
	Town of Minco, Oklahoma	Expand or modify secondary treatment plant	B
	City of Oklahoma City, Oklahoma	Construct larger secondary treatment plant (Northside Plant) at new location	B
	U. S. Dept. of the Air Force, Tinker Air Force Base, Oklahoma City, Oklahoma	Provide collection system and expand industrial waste treatment facilities	A
21	Town of Nicoma Park, Oklahoma	Provide collection system and secondary treatment plant	B
22	Town of Noble, Oklahoma	Modify and improve plant operation	B
23	City of Chandler Oklahoma	Expand or modify secondary treatment plant	B
	City of Shawnee, Oklahoma	Expand or modify secondary treatment plant	B
	Town of Wellston, Oklahoma	Expand or modify existing treatment facilities	B

<u>Location</u>	<u>Responsibility</u>	<u>Need</u>	<u>Priority</u>
-----------------	-----------------------	-------------	-----------------

Waste Treatment (Continued)

24	Town of Earlsboro, Oklahoma	Expand or modify secondary treatment	B
25	Town of Asher, Oklahoma	Provide collection system and secondary treatment plant	B
26	City of Maud, Oklahoma	Expand or modify secondary treatment plant	B
27	Town of Depew, Oklahoma	Add secondary treatment unit to primary plant	B
28	City of Bristow, Oklahoma	Improve plant operation	B
29	Town of Meeker, Oklahoma	Expand or modify secondary treatment plant	B
30	City of Prague, Oklahoma	Expand or modify secondary treatment plant	B
31	City of Henryetta, Oklahoma	Expand and modify secondary treatment plant	B
32	Town of Wetumka, Oklahoma	Add secondary unit to existing primary plant and expand or modify existing secondary treatment plant	B
33	Town of Pittsburg, Oklahoma	Add secondary treatment unit to primary plant	B
34	Town of Hartshorne, Oklahoma	Expand secondary treatment plant	B

Flow Regulation

23	Corps of Engineers	North Canadian and Deep Fork Rivers - storage to provide additional flow below Oklahoma City for water quality control	A
----	--------------------	---	---

<u>Location</u>	<u>Responsibility</u>	<u>Need</u>	<u>Priority</u>
-----------------	-----------------------	-------------	-----------------

Flow Regulation (Continued)

35	Corps of Engineers	Canadian River - continuous release of water at all times from Eufaula Reservoir sufficient to maintain water quality and protect fish and other aquatic life in river below Eufaula Dam	B
----	--------------------	--	---

Other Pollution Control Practices

Basinwide	Agricultural Activities	Improvement of land management	A
Basinwide	Department of Agriculture Local Institutions	Construction of flood retarding and silt retention structures in cooperation with the Department of Agriculture	B
5 & 20	States of Oklahoma & Texas & local interests	Prevention of water pollution from cattle feed lots	A
Basinwide	States of New Mexico, Oklahoma & Texas & oil field operators	Prevention of mineral pollution from manmade sources	A

Institutional Practices

Basinwide	States of New Mexico, Oklahoma, & Texas	Prepare and adopt water quality standards	B
Basinwide	States of Oklahoma and Texas	Consider legislation to provide appropriations for state participation in grants and loans for construction of sewage treatment works	B
Basinwide	State of New Mexico	Provide increased appropriations for state grant program for construction of sewage treatment works	B

<u>Location</u>	<u>Responsibility</u>	<u>Need</u>	<u>Priority</u>
<u>Institutional Practices</u>			
Basinwide	States of New Mexico, Oklahoma, & Texas	Consider expansion of water quality control surveillance program (including treatment plant operation and maintenance)	A
Basinwide	States of New Mexico, Oklahoma, & Texas	Prepare and keep up-to-date a complete industrial waste inventory for industries not connected to municipal treatment systems.	B
<u>Research</u>			
Basinwide	FWPCA, States of New Mexico, Oklahoma and Texas	Conduct research on the methods for control and/or disposal of brines from man-made sources.	A
Basinwide	FWPCA, Bureau of Reclamation & Department of Agriculture	Develop economically feasible means of preventing water quality degradation due to irrigation return flows	A
17	FWPCA, Bureau of Reclamation, State of Oklahoma	Determine the effect the irrigation of 16,000 acres of land with water from Canton Reservoir will have on the water quality of the North Canadian River below Canton Reservoir. Also determine the need for and feasibility of providing storage for water quality control in Canton Reservoir.	B
Basinwide	FWPCA, States of Oklahoma and Texas	Determination of appropriate treatment methods for wastes from cattle feed lots.	B

III. Immediate Water Pollution Control Needs

The two major streams, the North and South Canadian Rivers, which drain the Canadian River Basin have similar natural characteristics and pollution problems. Pollution in both of these rivers causes serious water quality problems and prevents the full utilization of the Canadian River Basin's water resources. A variety of measures and actions are needed immediately in the basin to control water pollution which is resulting in high mineral content, large silt loads, low dissolved oxygen, obnoxious and unsightly conditions, and rapid changes in environmental conditions such as temperature, water velocity and level, organic content and mineral concentration. The beneficial water uses prevented or damaged by water pollution in the Canadian River Basin include municipal and industrial water supply, fish and wildlife propagation, irrigation, fishing, and other recreational pursuits.

The actions recommended here though not all encompassing are, however, prerequisite to good water quality planning and should be included in local, state, and Federal programming for water pollution control. Background for the listed immediate water pollution control needs is summarized in Chapter VI.

Waste Treatment

The Town of Maxwell, New Mexico, needs to provide a new primary and secondary treatment plant to replace the original plant lost in a 1966 flood. Tinker Air Force Base, Oklahoma, needs to expand its industrial waste collection and treatment facilities in order to eliminate the discharge of untreated industrial wastes. Panhandle Gravel, Inc. near Amarillo, Texas, and Western Sand and Gravel, Inc. in Oldham County, Texas, need to provide sedimentation for the removal of suspended solids. The Phillips Chemical Company near Borger, Texas, needs to provide additional treatment of domestic and industrial wastes. The Colorado Interstate Gas Company, Bivins Station, in Moore County, Texas, needs to provide treatment of domestic and industrial wastes. Implementation of the above projects should carry a high priority.

New or expanded treatment facilities are needed by at least 41 other communities and two Federal installations. Two other industries need additional treatment of domestic and industrial wastes and 3 communities need to provide better operation of present treatment facilities. (See summary table, Chapter II). The list of needs is not considered all inclusive and does not reflect projected needs due to future obsolescence or to expanded or changed water uses.

Flow Regulation

Quality control releases by the Corps of Engineers from Eufaula Reservoir are needed so that flows below Eufaula Dam will be sufficient at all times to maintain water quality and protect fish and other aquatic life. These quality releases are needed in order that a good fishery may be established and maintained in the Canadian River between Eufaula Dam and its confluence with the Arkansas River, a distance of 17 miles.

There is a need for water quality control storage and/or flows on the North Canadian and Deep Fork River to supplement low flows in the streams and increase the streams' waste assimilative capacity. This storage is needed to protect water quality in these streams below the effluent discharges from Oklahoma City. Arcadia Reservoir, a Corps of Engineers multi-purpose project which is proposed for construction on the Deep Fork River, would provide 20 mgd for water quality control purposes in this river, in addition to flow control and recreation use. Water for quality control purposes on the North Canadian River would best be provided from the proposed water conveyance canal which would transport water from four authorized Corps of Engineers reservoirs in Southeast Oklahoma to the Oklahoma City area. These four reservoirs, Boswell, Hugo, Clayton, and Tuskahoma, are planned to provide a total of 594 mgd for various water quality control purposes.

Other Pollution Control Practices

Land management improvements by local agricultural activities and flood retarding and silt retention structures built by the Department of Agriculture and local institutions are needed to reduce silt problems in various streams in the Canadian River Basin.

State programs are needed in Oklahoma and Texas to examine all animal feedlot waste disposal practices, and if necessary, require drainage control and/or waste treatment to prevent stream pollution.

Increased surveillance and enforcement actions by the States of New Mexico, Oklahoma and Texas are needed to reduce the quantity of man-made mineral pollutants discharged to surface water courses.

Institutional Practices

To strengthen the states' position on prevention, control, and abatement of stream pollution, water quality standards are needed on interstate and intrastate streams. State participation is needed in Oklahoma and Texas in the waste treatment plant construction grants program to accelerate the construction of needed improvements. The State of New Mexico needs to increase the appropriations for its present grant program for the construction of sewage treatment works. Increased surveillance and operation inspection of sewage and industrial waste treatment plants are needed to locate and identify existing or potential serious pollution problems. For more rigid control over industrial pollution and aid in solving complex stream quality problems, a complete and up-to-date inventory is needed of industrial waste discharges to basin streams, listing quantity and quality of effluent and other pertinent data.

Research

Research by Federal Water Pollution Control Administration is needed to determine economically feasible methods of control and/or disposal of brines originating from man-made sources. There is also a need for research by the Federal Water Pollution Control Administration, Bureau of Reclamation, and the Department of Agriculture to develop economically feasible means of preventing water quality degradation due to irrigation return flows.

The Federal Water Pollution Control Administration, the Bureau of Reclamation, and the State of Oklahoma should conduct a joint study to determine what effect the irrigation of 16,000 acres of land with water from Canton Reservoir will have on water quality of the North Canadian River below Canton Dam. This study should also determine the need for and feasibility of providing storage for water quality control in Canton Reservoir.

Further research by the Federal Water Pollution Control Administration and the States of Oklahoma and Texas is needed to determine methods for the control and/or treatment of cattle feedlot wastes.

IV. Costs

The estimated cost of pollution control measures listed in the summary table is shown in the following tabulation:

<u>ITEM</u>	<u>ESTIMATED COST</u>
<u>Municipalities:</u>	
New or additional treatment facilities	\$49,296,000
Expansion of treatment facilities	2,751,000
Sub-Total	\$52,047,000
<u>Industries:</u>	
Industrial waste treatment facilities	\$ 1,451,000
<u>Federal Installations:</u>	
Expansion of treatment facilities	\$ 693,000
<u>Flow Regulation:</u>	
First cost of water quality storage in proposed Arcadia Reservoir on Deep Fork River	\$ 8,849,000
Estimated first cost of water quality storage in authorized Hugo and Clayton Reservoirs and canal for conveyance of this water to Oklahoma City vicinity for quality control on North Canadian River	\$142,265,000
Sub-Total	\$151,114,000
<u>Cattle Feedlot Drainage</u>	
The estimate includes only the cost for initial construction of waste retention ponds to prevent slug loads of feedlot drainage from entering streams during heavy rainfall periods. These ponds would not provide "treatment" of the waste. Costs for treatment would greatly exceed the amount shown.	
<u>Industrial Waste Inventory:</u>	
Inventory of industries not connected to municipal treatment systems	\$ 130,000
TOTAL	\$205,635,000

No estimates were made of the cost of land management improvement programs, silt and mineral pollution control programs, and other institutional, research, and flow regulation programs.

Of the total cost, approximately \$153,363,000, exclusive of land management and mineral pollution control programs and institutional and research costs, would be needed for control measures listed under priority "A" in the summary table.

V. Recent Progress in Pollution Control

Waste Treatment

State pollution control agencies in New Mexico, Texas, and Oklahoma have been very successful in encouraging proper treatment of municipal waste in the Canadian River Basin. In the Oklahoma portion of the basin, which includes the largest percentage of the population in the basin, only four communities do not have secondary treatment. Texas has established a permit system to regulate all municipal and industrial waste discharges. Surveillance of treatment plant operation is provided by the state pollution control agencies and assistance is provided where necessary.

Through a continuing Federal construction grants program, treatment facilities and appurtenant works have been constructed at 63 communities in the basin since 1958. Fifty-eight of these communities are located in the Oklahoma portion of the basin. Under this program, nine additional projects are under construction and grant offers have been made for 17 other projects.

Mineral Pollution Control

The Public Health Service, Division of Water Supply and Pollution Control (now FWPCA), completed a basic study in 1964 on water quality, sources of natural and man-made salt pollution, and suggested corrective measures for the Arkansas-Red River Basins. The study area included the Canadian River Basin. The study indicated that significant progress had been made in Texas and Oklahoma in the control of man-made sources of mineral pollution which are the primary sources of pollutants in the Canadian River Basin. Between 1951 and 1962, the chloride load in the Canadian River at Whitefield, Oklahoma, had been reduced by about 75%. Although this reduction is not enough to permit full usage of the streams in the basin, it represents a measureable improvement in water quality as a result of the states' programs to reduce mineral pollution caused by man's activities in the basin.

Effective June 1, 1966, the Corporation Commission of Oklahoma issued an order requiring that all earthen pits used for the handling, storage, or disposal of deleterious substances produced, obtained, or used in connection with the drilling or operation of wells or the refining or processing of oil or gas must be sealed with an impervious material and operated in such a manner as to prevent the

escape of any deleterious substances. Sealing of the earthen pits is to be completed in 1967. The Texas Railroad Commission has under consideration a statewide "no pit" order. This order would eliminate the discharge of oil field brines to the surface of the ground except where specific exceptions to the order are made. It is expected that these two programs in Oklahoma and Texas will further reduce the man-made mineral pollution in the various streams of the Canadian River Basin.

Silt Control

The U. S. Department of Agriculture has been working for many years to control land erosion in the Canadian River Basin. They have contributed to the construction of many floodwater retarding structures, built retention basins, and given technical advice and aid on land treatment.

VI. Background for Recommendations

Pertinent Basin Characteristics

The Canadian River Basin has its headwaters in the northeast corner of New Mexico where both the North and South Canadian Rivers begin a few miles apart along the eastward slope of the Rocky Mountains. After leaving New Mexico, the two rivers generally parallel each other across Texas and Oklahoma to their confluence at Eufaula Reservoir in Eastern Oklahoma. The South Canadian River has a total drainage area of 47,705 square miles including the North Canadian River's drainage area of 18,040 square miles. Because of the arid conditions and ill-defined drainage of the western portion of the basin, 9,700 square miles of drainage area are considered non-contributing. The Canadian River begins at an elevation of about 9,000 feet near Raton, New Mexico, and flows for about 1,000 miles to its confluence with the Arkansas River at an elevation of 440 feet.

The New Mexico portion of the basin's drainage area varies from gently rolling plains with well defined drainage to rough, broken, and arid uplands. The South Canadian River in the Texas panhandle and the North Canadian River in the Oklahoma Panhandle dissect the High Plains physiographic section. Across the High Plains, the land surface has a slope in an eastward direction of about 15 feet per mile. In the Oklahoma portion of the drainage area, the rivers cross gently rolling plains country and the river channel generally has an average slope of less than 3 feet per mile.

The New Mexico, Texas, and Western Oklahoma portion of the Canadian River Basin has an arid to semi-arid climate characterized by low rainfall and runoff, high evaporation, and frequent strong winds. As the river moves eastward, rainfall and runoff increases and evaporation decreases. The average annual precipitation of the Canadian River Basin varies from less than 15 inches in the western part to over 42 inches at its mouth. Average annual runoff in the basin varies from less than 0.25 inches per square mile in the west to over 6 inches in the east. At its mouth, the Canadian River has an aggregate annual runoff of 1.6 inches per square mile. From its source to near its mouth, the Canadian River and almost all of its tributaries have experienced zero flow. The flow characteristics at several locations in the Canadian River Basin are shown in Table I. The extremely low runoff values shown in Table I vividly

illustrate the arid character of the western portion of the basin. The high mean daily flow in comparison with the zero minimum flows indicate that much of the basin's stream flow results from flood flows.

Reservoirs in the basin include Conchas, Ute, and Lake Meredith (Sanford) on the South Canadian River and Fort Supply and Canton on the North Canadian River. Optima Reservoir is presently under construction on the North Canadian River near Guymon, Oklahoma. Eufaula Reservoir, at the confluence of the North and South Canadian Rivers, is an important segment of the multi-purpose plan for development of the entire Arkansas River Basin.

Table 2 shows representative samples of the quality of water available in the Canadian River Basin.

TABLE 1
STREAMFLOW CHARACTERISTICS-CANADIAN RIVER BASIN

<u>Stream & Location</u>	<u>Drainage Area</u>	<u>Lowest Recorded Flow</u>	<u>Average Annual Runoff</u>	<u>Mean Daily Flow</u>	<u>Average Annual Yield</u>	<u>Irrigation Diversion Above Sta.</u>
	<u>Square Miles</u>	<u>cfs</u>	<u>in/sq. mi.</u>	<u>cfs</u>	<u>ac-ft/yr</u>	<u>Irrigated Acres</u>
Canadian River nr Taylor Springs, New Mexico	2,850	0	.55	115	83,260	30,000
Canadian River nr Sanchez, New Mexico	6,015	0	.53	236	170,900	56,000
Canadian River at Logan, New Mexico	11,141	0	.31	257	185,100	93,000
Canadian River nr Amarillo, Texas	19,445	0	.30	425	307,700	93,000
Canadian River at Calvin, Oklahoma	27,952	0	.88	1,804	1,306,000	Not Reported
North Canadian River at Woodward, Oklahoma	11,589	0	.28	239	173,000	Not Reported
North Canadian River at Wetumka, Oklahoma	14,290	0	.68	714	516,900	Not Reported
Canadian River nr Whitefield, Oklahoma	47,576	0.4	1.6	5,617	4,067,000	Not Reported

Source: U. S. Geological Survey

TABLE 2
WATER QUALITY - CANADIAN RIVER BASIN

Stream & Location	Date	Mean Daily Flow cfs	Sulphate (SO ₄) mg/l	Chloride (Cl) mg/l	Total Hardness as CaCO ₃ mg/l	Total Dissolved Solids mg/l
Conchas Canal below Conchas Dam, New Mexico *	August 5, 1965 July 17, 1964	146 194	218 334	11 19	250 338	440 630
Ute Reservoir near Logan, New Mexico	June 30, 1965	Top Bottom	191 44	54 11	168 70	556 181
Revuelto Creek near Logan, New Mexico	June 28-29, 1965 July 20, 1964	8.0 23.0	214 634	70 62	134 351	1030 1200
Canadian River near Glenrio, New Mexico (6 miles upstream from N. W.-Tex. State Line)	July 1, 1965 July 23, 1964	20.6 0.1	- -	1920 1250	470 384	- -
Canadian River near Amarillo, Texas	July 1-31, 1964	8.3	91	108	271	724
North Canadian River near Wetumka, Oklahoma	July 1-13, 1964	66.5	65	540	1310	420
Little River near Norman, Oklahoma	June 16, 1964	2.3	45	80	284	415
Little River near Sasakwa, Oklahoma	June 12-18, 1964	28.6	23	515	340	1090
Canadian River near Whitefield, Oklahoma	July 5-16, 1964	21.6	7.4	270	230	638

Source: U. S. Geological Survey

* Irrigation diversion from Conchas Reservoir

The population of the Canadian River Basin is approximately 1,000,000. Major population centers are Oklahoma City (325,000), Norman (34,000), Midwest City (36,000) and Shawnee (25,000), Oklahoma and Amarillo (138,000), Texas.

Water Quality Problems

Water quality in the Canadian River Basin suffers its greatest degradation due to the natural characteristics of the basin. Silt and salt are the two pollutants which create the basin's most critical water quality problems and prevent or hinder many beneficial water uses. Man's activities have intensified and contributed to the amount of silt and salt entering the basin's waters. The quality of surface waters in the Canadian River Basin is also altered by municipal and industrial discharges, cattle feedlot drainage, and reservoir operation.

Silt

From below Conchas Reservoir to its mouth, the South Canadian River is plagued by an unusually high silt load. The South Canadian River has an extremely wide, sandy channel along which the flow generally meanders through the sand from bank to bank. The river is a heavy sediment-bearing stream with a shifting bed and unstable banks, sheet and gully erosion, bank caving, and bed movement. During high water, the sediment deposited in the channel is picked up by the river and transported in suspension downstream. The sediment is deposited in the channel as the river's velocity decreases and a new thalweg and sand dunes are formed along the channel. The sand in the river bed is over 100 feet thick in the Texas Panhandle and it is 35 feet thick at Calvin, Oklahoma. The river tends to cut away its banks so badly that bridges have had to be protected by extensive control structures.

The Corps of Engineers have found that less than one percent of the annual sediment load at the Whitefield, Oklahoma, gaging station occurs when the flow is less than 1,000 cfs, even though such flows occur about 40 percent of the time. This shows the effect of the turbulent, high velocity characteristics of the South Canadian River.

The sediment problem in the North Canadian River is similar to the South Canadian's but the magnitude of the problem is less in the North Canadian River. The sediment load carried by the

two rivers is illustrated in Table 3. A comparison of the drainage areas shown in this table and in Table 1, shows the large amounts of land area that have no natural drainage to any river.

TABLE 3
SUSPENDED SEDIMENT LOADS-CANADIAN RIVER BASIN

Stream & Location	Sediment Contributing Drainage Area	Average Per Cent Sediment Content by Weight	Average Annual Sediment Load	Unit Sediment Load
	Square Miles	Per Cent	tons/yr	ac-ft/sq.mi./yr
Canadian River at Amarillo, Texas	15,376	3.05	12,720,000 <u>1/</u>	0.544
Canadian River at Calvin, Oklahoma	23,151	1.37	27,500,000 <u>2/</u>	0.78
North Canadian River at Woodward, Oklahoma	5,283 <u>3/</u>	0.86	2,948,000 <u>2/</u>	0.37
North Canadian River into Canton Reservoir, Oklahoma	6,081 <u>3/</u>	0.60	1,952,000 <u>2/</u>	0.21
North Canadian River nr Wetumka, Oklahoma	9,391	0.47	3,950,000 <u>2/</u>	0.28
Canadian River near Whitefield, Oklahoma	37,822	0.70	45,000,000 <u>2/</u>	0.78

Source: Corps of Engineers

1/ Calculated as the product of percent sediment and average annual flow.

2/ Sediment load as measured

3/ Area does not include 1,735 square mile drainage area above Ft. Supply Dam on Wolf Creek.

The Corps of Engineers have found that Canton Reservoir has materially decreased the suspended sediment load of the North Canadian River down to Oklahoma City, Oklahoma. As the river travels eastward from Oklahoma City, it again picks up a large silt load so that by the time it reaches Wetumka, Oklahoma, no improvement in the suspended sediment load carried by the North Canadian River can be attributed to the operation of Canton Reservoir. The North Canadian River below Oklahoma City has been subject to severe bank caving and widening of its stream bed within the past 20 years.

The adverse conditions created by the sediment-filled channel of the Canadian River creates a highly selective environment for aquatic life. Rarely is it possible to find any benthic invertebrates in the river bed and only the most hardy and adaptable types of aquatic life are able to exist in the Canadian River.

The high silt load and channel characteristics of the Canadian River make the development of storage reservoirs extremely difficult. If use is to be made of the Canadian River's water, means will have to be found to control the silt load so that reservoirs can be developed where there is a need for water.

Salt

The mineral quality of the North and South Canadian Rivers is degraded by salt from man's activities and from natural sources. Between Logan, New Mexico, and the Texas State Line, the water quality of the South Canadian River is badly degraded by irrigation return flows and to a lesser degree by natural salt seepage. This degradation is seriously affecting the quality of the water being stored downstream for municipal and industrial water supply in Lake Meredith, located near Borger, Texas.

Water for the irrigation of 93,000 acres is diverted from the Canadian River above Logan, New Mexico. An average of 75,000 acre-feet is diverted each year from Conchas Reservoir for the irrigation of 36,000 acres in the vicinity of Tucumcari, New Mexico. The return flows from this irrigation project enter the Canadian River just below Logan, New Mexico, through Revuelto Creek.

A comparison of the water quality diverted from Conchas Reservoir and the quality of the irrigation waters returned in Revuelto Creek shows a large increase in the chloride and total dissolved solids content of the return flows. A review of additional data shows that the quality of water in Ute Reservoir is

less satisfactory than the water quality of Conchas Reservoir. The most critical degradation of water quality occurs between Ute Reservoir and the New Mexico-Texas State Line.

The formations underlying the High Plains of the Texas and Oklahoma Panhandles contain salt. Both of the Canadian Rivers dissect the High Plains and natural salt seeps from the underlying formations into the two rivers. Additional salt is added to both rivers from the discharge of brines from oil and natural gas production. The South Canadian River from Lake Meredith to Eufaula Reservoir is generally of marginal quality for municipal water supply due to its high mineral content, and no use of any consequence is made of its waters downstream from Lake Meredith.

Oklahoma City is able to use the North Canadian River for municipal water supply by storing high flows of good quality in off stream reservoirs. If the salt in the North and South Canadian Rivers could be reduced, the Oklahoma City area would have another much needed source of municipal water.

Downstream from Oklahoma City, large amounts of brine resulting from the production of oil are discharged to the North Canadian River and two of its major tributaries, the Little River and the Deep Fork River. The data in Table 2 illustrates the water quality degradation of the Little River due to oil field brines. It is suspected that the salt content of the North Canadian River and its tributaries has contributed to the loss of vegetation along the river channels and the subsequent caving of the river banks. Table 4 shows the average flow weighted ion concentrations which were obtained by continuous monitoring during Water Year 1964.

TABLE 4
WATER QUALITY AS DETERMINED BY CONTINUOUS MONITORING
CANADIAN RIVER BASIN

<u>Stream & Location</u>	<u>Date</u>	<u>Mean</u>	<u>Specific</u>	<u>Sulphates</u>	<u>Chlorides</u>
		<u>Daily</u>	<u>Conductance</u>		
		<u>Flow</u>	<u>at 25°C</u>	<u>(SO₄)</u>	<u>(Cl)</u>
		<u>cfs</u>	<u>umhos</u>	<u>mg/l</u>	<u>mg/l</u>
Little River nr. Sasakwa, Okla.	June 1964	77	1590	95	455
	July 1964	2.7	5330	13	1710
	W Year 1964	111	730	49	165

TABLE 4 continued
WATER QUALITY AS DETERMINED BY CONTINUOUS MONITORING
CANADIAN RIVER BASIN

<u>Stream & Location</u>	<u>Date</u>	<u>Mean Daily Flow</u>	<u>Specific Conductance at 25°C</u>	<u>Sulphates (SO₄)</u>	<u>Chlo.ides (Cl)</u>
Canadian River at Calvin, Oklahoma	July 1964 W Year 1964	16 350	1420 847	94 93	318 164
North Canadian River nr. Wetumka, Okla.	July 1964 W Year 1964	45 235	2230 920	117 56	568 203
Canadian River nr. Whitefield, Okla.	June 1964 July 1964 W Year 1964	3.8 149 98	1160 574 1090	90 43 85	239 105 222

Source: FWPCA's Arkansas-Red River Water Quality Conservation Project

The data in Table 4 illustrates the variability of the North and South Canadian Rivers' water quality. This variability makes it necessary to continuously monitor these streams to obtain sufficient data to objectively answer questions regarding their water quality. Such information makes it clear that any water use which may be contemplated for either of these two rivers must be carefully planned.

A common method used for the disposal of oil field brines is subsurface reinjection. Often times the injected salt water is used to obtain secondary recovery of oil production by means of water flooding. In many of the water flood operations, the pollution of fresh water aquifers by the injected salt water brines is a critical problem. The injected salt water finds its way into the fresh water aquifers through abandoned, unplugged oil wells and leakage in the injection wells. The injection pressures used for many water flood operations are so high that the salt water breaks through formations, well casings, and packings. At the present time, water flood operators in the Canadian River Basin are not required to plug, locate, or otherwise attempt to control salt pollution resulting from unplugged wells. Since many of the old wells were poorly cemented, if at all, they act as an open pipe line from the disposal formation to the fresh water aquifer. The

quality of water available in many water wells has been greatly degraded and unacceptable for drinking purposes due to the intrusion of salt water into fresh water aquifers.

Municipal and Industrial Wastes

The assimilative capacity of most streams in the Canadian River Basin is not sufficient to completely prevent the occurrence of local problems due to the discharge of secondary treated municipal and industrial wastes. Most municipalities in the basin have secondary waste treatment plants and the problems which develop due to the discharges from these plants are usually in the immediate area of the discharge. A large number of Texas communities only have primary treatment but the waste discharged from these plants usually disappears into a dry stream bed or is evaporated before reaching a flowing water course.

The Town of Maxwell, New Mexico, lost its sewage treatment plant in a 1966 flood. Untreated sewage from this town is presently being discharged to the receiving stream causing a depletion of the dissolved oxygen and resulting in damages to aesthetics and recreational uses.

Phillips Chemical Company near Borger, Texas, degrades the organic and inorganic quality of the Canadian River by the discharge of untreated industrial wastes. The concentration of minerals in the company's effluent is considerably higher than the water supply due to consumptive water losses resulting from cooling and other processes. The extent of mineral degradation these wastes have on the Canadian River should be determined and appropriate treatment facilities installed to protect the water quality of the Canadian River. The organic wastes from Phillips Chemical Company damage fish and other aquatic life in the Canadian River. These wastes should also be treated before discharge.

Panhandle Gravel, Incorporated, near Amarillo, and Western San and Gravel, Incorporated, in Oldham County, Texas, both produce industrial waste waters which are heavy in suspended solids. These discharges contribute to the sediment load in the river and are damaging to aesthetics and recreational uses. Local nuisance conditions are created by untreated industrial and domestic waste discharges from the Colorado Interstate Gas Company, Bivins Station, Moore County, Texas.

Tinker Air Force Base, near Oklahoma City, discharges large quantities of industrial wastes from various aircraft maintenance and repair operations. Adequate treatment is provided for only a small percentage of these wastes. These wastes are primarily inorganic and/or toxic in nature and create nuisance conditions detrimental to aesthetics and recreational uses.

Deep Fork and North Canadian Rivers below Oklahoma City

The Deep Fork and North Canadian Rivers below Oklahoma City are at times inadequate to assimilate the secondary treated municipal wastes discharged by Oklahoma City. Problems of low dissolved oxygen, high organic content, and offensiveness to sight and smell are water quality problems in these two rivers below Oklahoma City. Serious damages to aquatic life, such as fish kills and almost complete loss of aesthetic values are a result of poor water quality in the Deep Fork and North Canadian Rivers.

Canadian River below Eufaula Reservoir

Under normal operating procedures, there are no water releases from Eufaula Reservoir on the weekends. This periodic lack of flow below Eufaula Reservoir prevents the establishment of a good fishery in the Canadian River between Eufaula Dam and its confluence with the Arkansas River, a distance of 17 miles. These conditions in this portion of the river result in damages to fishing and other recreational uses of the river.

Cattle Feedlot Drainage

Animal wastes have long been identified as significant sources of pollution. Runoff from cattle feedlots following rainfall is characterized by a high biochemical oxygen demand, high ammonia content, and heavy bacterial populations. Pollution from feedlots is transported by surface runoff and therefore discharges to streams only as long as runoff continues. This results in a slug load of organic material on a receiving stream that can be damaging, producing nuisance conditions, health hazards, and fish kills.

In the Canadian River Basin, there are approximately 55 cattle feedlots with feeding capacities in excess of 1,000 head. The total capacity of these lots is about 220,000 head. More than 90 percent of the cattle fed are located in the Panhandle of Oklahoma and the upper Panhandle of Texas. There is another area of concentrated cattle feeding just west of and including Oklahoma City. Only a few of the cattle feedlots in the basin provide proper control of feedlot drainage.

VII. BIBLIOGRAPHY

1. New Mexico Advisory Council on Water Pollution Control, Minutes of Board's Meeting, Oct. 1966, Santa Fe, New Mexico.
2. New Mexico Department of Public Health, Unpublished Data and Information from Department's Files and Personnel, Jan. 1967.
3. Oklahoma Corporation Commission, Department of Agriculture, Department of Health, Department of Wildlife Conservation and Water Resources Board, Unpublished Data and Information from Each Agencies Files and Personnel, Feb. 1967, Oklahoma City, Oklahoma.
4. Oklahoma State Department of Health, "Biennial Report, 1965-1966," Dec. 1966, State Board of Health, Oklahoma City, Oklahoma.
5. Oklahoma State Department of Health, "Municipal Sewage Facilities of Oklahoma," June 1965, Division of Sanitary Engineering, Oklahoma City, Oklahoma.
6. Texas Board of Water Engineers, "Bulletin 6016, Reconnaissance Investigation of the Ground Water Resources of the Canadian River Basin, Texas," Sept. 1960, Texas Board of Water Engineers, Austin, Texas.
7. Texas Water Pollution Control Board, Unpublished Data and Information from Board's Files and Personnel, Jan. 1967, Austin, Texas.
8. Texas Water Pollution Control Board, "Waste Disposal Permits," 1963 to present, State of Texas, Austin, Texas.
9. U. S. Army Engineer District, Tulsa, "Interim Survey Report on Central Oklahoma Project," Sept. 1966, Corps of Engineers, Tulsa, Oklahoma.
10. U. S. Army Engineer District, Tulsa, "Project Design Memorandum No. 6-2 Sedimentation Eufaula Reservoir," June 1959, Corps of Engineers, Tulsa, Oklahoma.
11. U. S. Army Engineer District, Tulsa, "Report of Sedimentation Resurvey, Canton Reservoir, North Canadian River, New Mexico, Texas and Oklahoma, 1953, Arkansas River Basin," April 1958, Corps of Engineers, Tulsa, Oklahoma.

12. U. S. Army Engineer District, Tulsa, "Survey Report on Arkansas-Red River Basins, Water Quality Control Study, Texas-Oklahoma-Kansas, Part II," May 1966, Corps of Engineers, Tulsa, Oklahoma.
13. U. S. Department of Health, Education, and Welfare, Public Health Service, "Arkansas-Red River Basins, Water Quality Conservation," June 1964, Division of Water Supply and Pollution Control, Washington, D. C.
14. U. S. Department of Health, Education, and Welfare, Public Health Service, "1962 Inventory Municipal Waste Facilities, Region VII," Government Printing Office, Washington, D. C.
15. U. S. Department of Health, Education, and Welfare, Public Health Service, "Pollution Caused Fish Kills in 1963, 1964," Government Printing Office, Washington, D. C.
16. U. S. Department of Health, Education, and Welfare, Public Health Service, "Report on Water Pollution, North Canadian River Basin," April 1953, Public Health Service, Region VII, Dallas, Texas.
17. U. S. Department of Health, Education, and Welfare, Public Health Service, "Water Resources Study, Central Oklahoma Navigation Project, Deep Fork River Basin, Oklahoma," March 1964, Public Health Service, Region VII, Dallas, Texas.
18. U. S. Department of Health, Education, and Welfare, Public Health Service, "Water Resources Study, Southeastern Oklahoma and Southwestern Arkansas," July 1962, Public Health Service, Region VII, Dallas, Texas.
19. U. S. Department of the Interior, Bureau of Reclamation, "Reappraisal of the Canton Project-Oklahoma," Revised Aug. 1965, Bureau of Reclamation, Region 5, Amarillo, Texas.
20. U. S. Department of the Interior, Federal Water Pollution Control Administration, "Monthly and Yearly Summaries of Flow and Mineral Analyses for Water Years 1961-1964," Nov. 1966, Arkansas-Red River Comprehensive Project, Ada, Oklahoma.
21. U. S. Department of the Interior, Federal Water Pollution Control Administration, "Pollution Caused Fish Kills in 1965," Government Printing Office, Washington, D. C.
22. U. S. Department of the Interior, Geological Survey, "Compilation of Records of Surface Waters of the United States, October 1950 to September 1960, Part 7, Geological Survey Water-Supply Paper 1731," 1964, Government Printing Office, Washington, D. C.

23. U. S. Department of the Interior, Geological Survey, "Surface Water Records of New Mexico, various years through 1965," U. S. Geological Survey, Albuquerque, New Mexico.
24. U. S. Department of the Interior, Geological Survey, "Surface Water Records of Oklahoma, various years through 1965," U. S. Geological Survey, Oklahoma City, Oklahoma.
25. U. S. Department of the Interior, Geological Survey, "Surface Water Records of Texas, various years through 1964," U. S. Geological Survey, Austin, Texas.
26. U. S. Department of the Interior, Geological Survey, "Water Quality Records in New Mexico, various years through 1965," U. S. Geological Survey, Albuquerque, New Mexico.
27. U. S. Department of the Interior, Geological Survey, "Water Quality Records in Oklahoma, various years through 1964," U. S. Geological Survey, Oklahoma City, Oklahoma.
28. U. S. Department of the Interior, Geological Survey, "Water Quality Records in Texas, various years through 1964," U. S. Geological Survey, Austin, Texas.
29. U. S. Army Engineer District, Tulsa, "Survey Report on Hugo Reservoir, Kiamichi River, Oklahoma", November 1961, Corps of Engineers, Tulsa, Oklahoma.